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LAKE ALLEGAN, ALLEGAN COUNTY, MICHIGAN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
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Michigan National Guard

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT

ON

LAKE ALLEGAN

ALLEGAN COUNTY

MICHIGAN

EPA REGION V

WORKING PAPER No. 182

WITH THE COOPERATION OF THE

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

AND THE

MICHIGAN NATIONAL GUARD

FEBRUARY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identfying point sources and soliciting municipal participation in the Survey.

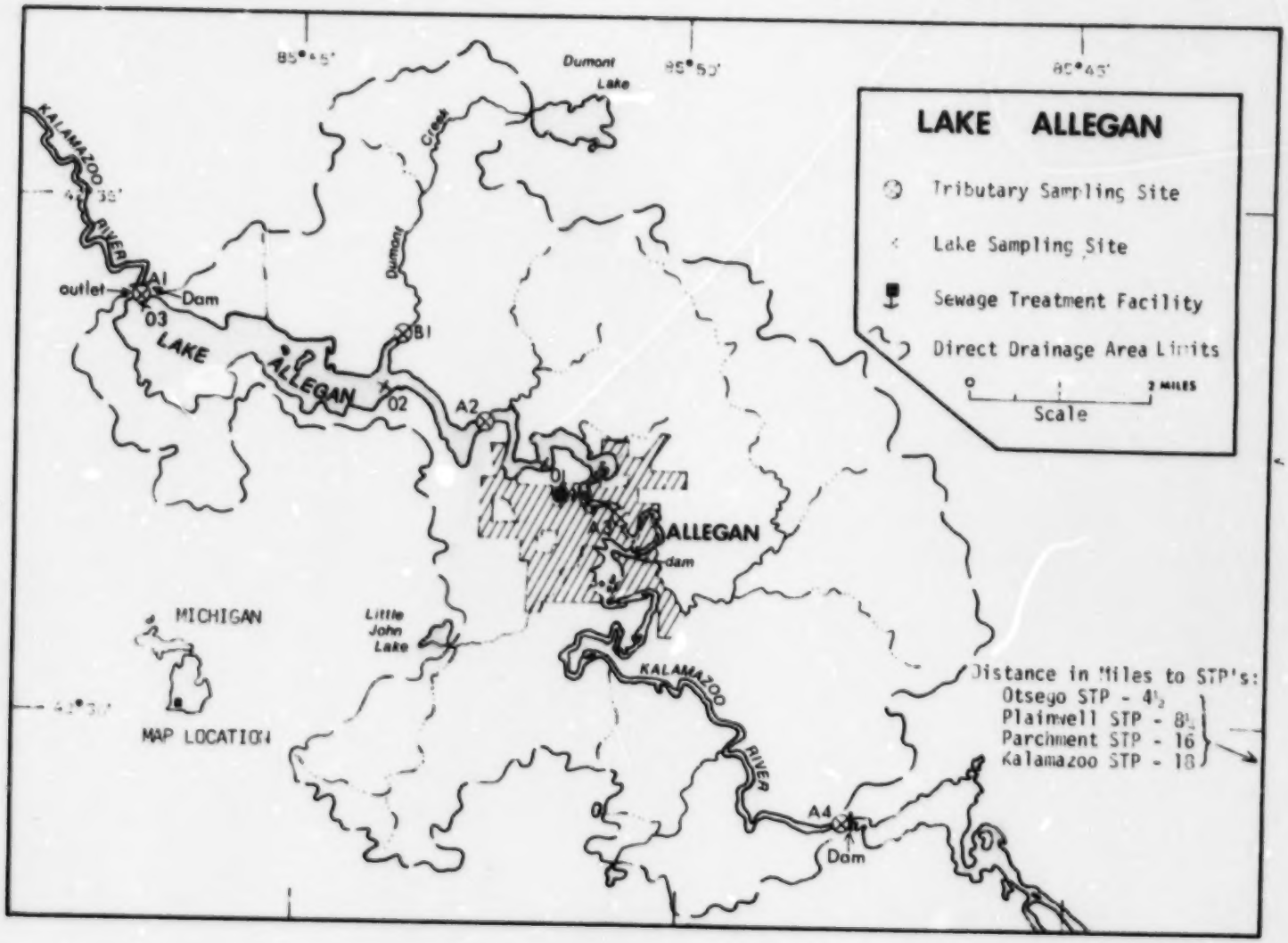
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


LAKE ALLEGAN
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
0
2 MILES
Scale
85°45'
85°50'
85°45'
Dumont Lake
Dumont Creek
KALAMAZOO RIVER
outlet
A1
Dam
03
LAKE ALLEGAN
B1
02
A2
01
ALLEGAN
dam
MICHIGAN
Little John Lake
KALAMAZOO RIVER
A4
Dam
MAP LOCATION
Distance in Miles to STP's:
Otsego STP - 4½
Plainwell STP - 8½
Parchment STP - 16
Kalamazoo STP - 18

LAKE ALLEGAN

STORET NO. 2603

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others (Anonymous, 1972a) show that Lake Allegan is eutrophic. Of the 35 Michigan lakes sampled in November when essentially all were well-mixed, 27 had less mean total phosphorus, 24 had less mean dissolved phosphorus, and 23 had less mean inorganic nitrogen; of all 41 Michigan lakes sampled, 32 had greater Secchi disc transparency, and 24 had less mean chlorophyll a*.

Survey limnologists observed that Lake Allegan was very turbid and had a high concentration of suspended particulate matter. They noted the presence of rooted aquatic vegetation in the shallows and reported a rather heavy blue-green algal bloom in September, 1972.

B. Rate-Limiting Nutrient:

There was a significant loss of phosphorus in the algal assay sample, and the results are not representative of conditions in the lake at the time the sample was collected.

The lake data indicate nitrogen limitation in June but phosphorus limitation in September and November.

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* See Appendix A.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Lake Allegan received a total phosphorus load at a rate over 12 times that proposed by Vollenweider (in press) as "dangerous"; i.e., 12 times the eutrophic rate (see page 13). While it is likely that Vollenweider's model is not applicable to water bodies with such a short hydraulic retention time, the existing trophic condition of Lake Allegan is evidence of excessive nutrient loads.

It is calculated that the municipal point sources included in this study contributed about 23% of the total phosphorus load. While even complete removal of phosphorus at these sources would still leave a loading rate of about 215 lbs/acre/yr or 24 $g/m^2/yr$ (i.e., about nine times the eutrophic rate), in view of the very short hydraulic retertion time, and the questionable applicability of Vollenweider's model, it is likely that a high degree of phosphorus removal at the munjcipal sources would at least reduce the incidence and intensity of nuisance algal blooms in Lake Allegan.

Now, it is known that there were unsampled point sources of nutrients in the Lake Allegan drainage (Knight and Lauff, 1969) beyond the 25-mile limit of the Survey*; and assuming the mean

* See Working Paper No. 1, "Survey Methods, 1972".

annual nutrient exports of Dumont Creek (page 12) are typical of non-point contributions in the drainage, it is calculated that the unsampled point sources contributed about 253,000 pounds of phosphorus and 729,000 pounds of nitrogen to the Kalamazoo River drainage (at station A-2 and thence to Lake Allegan) during the sampling year.

To effect a marked improvement in the trophic condition of Lake Allegan, it appears that control of phosphorus at all of the sampled and unsampled point sources will be necessary, and it is calculated that an overall 80% reduction of the point source load would reduce the loading rate to just over 11 g/m^2/yr, or less than five times Vollenweider's eutrophic rate.

2. Non-point sources (page 12)--During the sampling year, the phosphorus export of the Kalamazoo River was nearly four times that of Dumont Creek and is evidence of the significance of the unsampled point sources noted above.

In all, it is calculated that "non-point" sources contributed nearly 77% of the total phosphorus load to Lake Allegan during the sampling year.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry:

1. Surface area: 1,586 acres.
2. Mean depth: 11 feet.
3. Maximum depth: >20 feet.
4. Volume: 17,200 acre-feet†.
5. Mean hydraulic retention time: 7 days.

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Kalamazoo River	1,513.0 mi^2	1,238.9 cfs
Dumont Creek	14.4 mi^2	11.7 cfs
Minor tributaries & immediate drainage -	11.1 mi^2	11.2 cfs
Totals	1,538.5 mi^2	1,261.8 cfs

2. Outlet -

Kalamazoo River	1,541.0 mi^2**	1,261.8 cfs

C. Precipitation***:

1. Year of sampling: 42.7 inches.
2. Mean annual: 34.2 inches.

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† Martin and Hanson, 1966; mean depth and retention time calculated on basis of this volume.

* Drainage areas are accurate within ±5%; mean daily flows for 74% of the sampling sites are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.

** Includes area of lake.

*** See Working Paper No. 1.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake Allegan was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and usually from two or more depths at each station (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the second visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, depth-integrated samples were collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 8 feet at station 1, 6 feet at station 2, and 20 feet at station 3.

The results obtained are presented in full in Appendix C, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix C.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/14/72)		
Temperature (Cent.)	4.2	5.5	6.3	6.3
Dissolved oxygen (mg/l)	9.9	10.6	10.4	11.9
Conductivity (μmhos)	600	600	600	600
pH (units)	7.8	7.8	7.8	7.9
Alkalinity (mg/l)	218	227	227	236
Total P (mg/l)	0.092	0.123	0.111	0.180
Dissolved P (mg/l)	0.055	0.057	0.057	0.060
NO_2 + NO_3 (mg/l)	0.780	0.825	0.830	0.870
Ammonia (mg/l)	0.280	0.343	0.355	0.400
		ALL VALUES		
Secchi disc (inches)	16	29	32	36

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Number per ml
06/14/72	1.	Cyclotella	14,891
	2.	Melosira	1,594
	3.	Synedra	1,232
	4.	Gloeocapsa	326
	5.	Nitzchia	290
		Other genera	1,413
		Total	19,746
09/18/72	1.	Cyclotella	2,590
	2.	Melosira	1,386
	3.	Scenedesmus	813
	4.	Achnanthes	241
	5.	Synedra	241
		Other genera	1,115
		Total	6,386
11/14/72	1.	Lyngbya	2,857
	2.	Cyclotella	1,230
	3.	Synedra	597
	4.	Melosira	488
	5.	Achnanthes	362
		Other genera	741
		Total	6,275

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
06/14/72	01	66.6
	02	17.7
	03	5.5
09/18/72	01	28.5
	02	35.6
	03	24.8
11/14/72	01	1.6
	02	0.8
	03	1.7

C. Limiting Nutrient Study:

There was a loss of about 64% of the dissolved phosphorus in the algal assay sample from the time of collection to the beginning of the assay, and the results are not representative of conditions in the lake at the time the sample was taken.

The lake data indicate nitrogen limitation in June (N/P ratio = 10/1) but phosphorus limitation in September (N/P = 15/1) and November (N/P = 20/1).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Michigan National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May, when two samples were collected, and in January when ice cover prevented sampling at most sites. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in lbs/mi^2/year, in Dumont Creek at station B-1 and multiplying by the ZZ area in mi^2.

The operators of the Allegan, Kalamazoo, Otsego, Parchment, and Plainwell wastewater treatment plants provided monthly effluent samples and corresponding flow data. In this report, all of the nutrients from the Allegan STP were assumed to have reached Allegan Lake during the sampling

* See Working Paper No. 1.

year. However, because of two intervening impoundments in which sedimentation and/or biological assimilation could have occurred, only 50% of the phosphorus loads and 80% of the nitrogen loads from Kalamazoo, Otsego, Parchment, and Plainwell were assumed to have reached the lake.

In the following loading tables, the loads attributed to the Kalamazoo River are those measured at station A-2 minus the STP loads.

A. Waste Sources:

1. Known municipal* -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Allegan	4,000	primary	0.550	Kalamazoo River
Kalamazoo	83,800	act. sludge	31.775	Kalamazoo River
Otsego	3,915	trickling filter	0.740	Kalamazoo River
Parchment	2,000	trickling filter	0.346	Kalamazoo River
Plainwell	3,020	trickling filter	0.504	Kalamazoo River

2. Industrial** -

Reportedly, pulp and paper mill wastes, pharmaceutical wastes, and meat-packing wastes are discharged to the Kalamazoo River upstream of Lake Allegan. Whether these wastes are untreated, treated separately, or treated jointly with domestic wastes is not known, but it appears these wastes have a considerable impact on the lake (pages 2 and 3).

* Anonymous, 1972b.
** Knight and Lauff, 1969.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Kalamazoo River	339,020	76.3
Dumont Creek	820	0.2
b. Minor tributaries & immediate drainage (non-point load) -	630	0.1
c. Known municipal STP's -		
Allegan	11,060	2.5
Kalamazoo	76,740	17.3
Ostego	9,670	2.2
Parchment	2,100	0.5
Plainwell	4,040	0.9
d. Septic tanks -	insignificant	
e. Industrial (not known but probably significant) -	?	-
f. Direct precipitation* -	250	<0.1
Total	444,330	100.0

2. Outputs -

Lake outlet - Kalamazoo River 339,960

3. Net annual P accumulation - 104,370 pounds

* See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/yr	% of total
a. Tributaries (non-point load) -		
Kalamazoo River	3,969,620	69.5
Dumont Creek	30,850	0.5
b. Minor tributaries & immediate drainage (non-point load) -	23,780	0.4
c. Municipal STP's -		
Allegan	47,860	0.8
Kalamazoo	1,535,270	26.9
Ostego	41,860	0.7
Parchment	20,230	0.4
Plainwell	23,240	0.4
d. Septic tanks -	insignificant	
e. Industrial - (not known but probably significant) -	?	-
f. Direct precipitation* -	15,280	0.3
Total	5,707,990	100.0

2. Outputs -

Lake outlet - Kalamazoo River 6,880,620

3. Net annual N loss - 1,172,630 pounds

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr	N/P Ratio
Kalamazoo River	224	2,624	12/1
Dumont Creek	57	2,142	38/1

* See Working Paper No. 1.

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with very short hydraulic retention times.

Units	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
lbs/acre/yr	280.2	65.8	3,599.0	loss*
grams/m^2/yr	31.40	7.38	403.4	-

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Allegan:

"Dangerous" (eutrophic rate)	2.50
"Permissible" (oligotrophic rate)	1.25

* The apparent loss of nitrogen may be due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, nitrogen-rich ground water recharge, or possibly unsampled point sources between the inlet sampling station (A-2) and the outlet (A-1). However, a similar nitrogen loss has been observed at Shagawa Lake, Minnesota, which has been studied intensively by EPA's National Eutrophication and Lake Restoration Branch.

V. LITERATURE REVIEWED

Anonymous, 1972a. Biological survey of the Kalamazoo River, June-August, 1971. MI Dept. of Nat. Resources, Lansing.

Anonymous, 1972b. Treatment plant questionnaires (Allegan, Kalamazoo, Otsego, Parchment, and Plainwell STP's). MI Dept. Publ. Health, Lansing.

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Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	ALL VALUES MEAN TOTAL P	ALL VALUES MEAN DISS P	ALL VALUES MEAN INORG N	ALL VALUES 500-MEAN SEC	ALL VALUES MEAN CHLRA	ALL VALUES 15-MIN UO
[illegible]	[illegible]OWAY RESERVOIR	0.062	0.043	1.461	439.375	10.670	9.200
2641	CARO RESERVOIR	0.117	0.022	3.035	473.000	11.967	9.500
2642	BOARDMAN HYDRO POND	0.006	0.005	0.358	363.500	1.267	6.600
2643	ALLEGAN LAKE	0.123	0.057	1.168	470.222	20.[illegible]	12.600
2646	BARTON LAKE	0.121	0.006	1.489	456.167	27.000	14.050
2649	BELLEVILLE LAKE	0.118	0.048	1.420	465.250	28.262	8.200
2650	BETSIE LAKE	0.025	0.008	0.273	481.667	4.567	7.400
2653	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2657	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.008	9.240
2658	LAKE CHEMUNG	0.044	0.014	0.132	484.333	13.483	14.000
2661	CONSTANTINE RESERVOIR	0.027	0.008	0.910	456.167	30.317	7.500
2669	FORD LAKE	0.105	0.050	1.536	456.167	14.733	14.000
2671	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.000
2680	JORDAN LAKE	0.108	0.144	1.998	427.667	29.517	14.900
2683	KENT LAKE	0.040	0.015	0.417	485.000	33.944	13.000
2688	LAKE MACATAWA	0.197	0.129	2.358	477.600	25.600	12.200
2689	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.300
2699	MUSKEGON LAKE	0.007	0.003	0.469	430.444	9.511	14.000
2705	PENTWATER LAKE	0.027	0.017	0.496	430.667	16.083	14.000
2711	RANDALL LAKE	0.246	0.183	0.010	457.333	27.217	8.020
2712	ROGERS POND	0.026	0.015	0.183	439.500	8.133	9.600
2713	RUSS RESERVOIR	0.034	0.021	0.460	469.333	10.383	8.200
2714	SANFORD LAKE	0.016	0.008	0.307	458.750	13.791	8.300
2723	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.650	10.000
2725	UNION LAKE	0.083	0.004	1.252	495.500	15.667	8.200
2728	WHITE LAKE	0.027	0.019	0.367	417.778	9.211	13.400
2731	MONA LAKE	0.307	0.241	0.463	451.667	27.783	14.100
2732	LONG LAKE	0.163	0.148	0.749	418.400	10.867	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 1S-MIN DO
93	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CRYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.000
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.029	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: SDD-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
2640	HOLLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	286
2641	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
2642	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	565
2643	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	187
2644	BARTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2649	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2610	BETSIE LAKE	77 (27)	77 (27)	60 (20)	17 (6)	86 (30)	94 (33)	431
2613	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2617	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2618	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2621	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2629	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2631	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2640	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2643	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2648	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2649	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2659	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2665	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2671	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2672	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2673	ROSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	79 (26)	325
2674	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2683	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2685	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (26)	242
2688	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2691	HOWA LAKE	3 (1)	3 (1)	37 (13)	43 (15)	17 (6)	20 (7)	143
2692	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2603 ALLEGAN LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 1541.00

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2603A1	1541.00	1348.00	1428.50	1958.10	1889.60	1582.50	1233.20	880.87	790.27	812.41	929.19	1189.48	1196.00	1261.83
2603A2	1513.00	1314.00	1393.00	1909.00	1843.00	1543.00	1203.00	859.00	771.00	792.00	906.00	1082.00	1166.00	1230.94
2603B1	14.40	13.00	13.00	18.00	18.00	15.00	11.00	8.00	7.00	8.00	9.00	10.00	11.00	11.74
2603Z2	13.60	12.00	13.00	17.00	17.00	14.00	11.00	8.00	7.00	7.00	8.00	10.00	10.00	11.15

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 1541.00
SUM OF SUB-DRAINAGE AREAS = 1541.00

TOTAL FLOW IN = 15156.00
TOTAL FLOW OUT = 15158.02

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2603A1	10	72	1350.00	28	1500.00				
	11	72	1890.00	20	1760.00				
	12	72	1940.00	22	2130.00				
	1	73	2640.00						
	2	73	1640.00	5	1760.00				
	3	73	2390.00	5	2080.00				
	4	73	2490.00	12	2210.00	23	2650.00		
	5	73	2110.00	16	1690.00	31	3160.00		
	6	73	2060.00	29	1470.00				
	7	73	1430.00	24	1670.00				
	8	73	1330.00	23	1760.00				
	9	73	1010.00	28	1180.00				
2603A2	10	72	1320.00	28	1480.00				
	11	72	1850.00	20	1730.00				
	12	72	1900.00	22	2090.00				
	1	73	2600.00						
	2	73	1610.00	5	1730.00				
	3	73	2350.00	5	2040.00				
	4	73	2490.00	12	2210.00	23	2650.00		
	5	73	2070.00	16	1660.00	31	3100.00		
	6	73	2020.00	14	1680.00	29	1450.00		
	7	73	1400.00	24	1640.00				
	8	73	1310.00	23	1730.00				
	9	73	993.00	28	1160.00				

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2603 ALLEGAN LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
260361	10	72	12.60	28	14.00				
	11	72	17.60	20	18.50				
	12	72	18.10	22	19.90				
	1	73	24.70						
	2	73	15.30						
	3	73	22.30	5	19.40				
	4	73	23.30	12	20.60	23	24.80		
	5	73	19.70	16	15.80	31	29.50		
	6	73	19.10	14	16.00	29	13.80		
	7	73	13.30	24	15.00				
	8	73	12.40	23	16.50				
	9	73	9.40	28	11.10				
260327	10	72	11.90						
	11	72	16.70						
	12	72	17.10						
	1	73	23.30						
	2	73	14.40						
	3	73	21.10						
	4	73	22.00						
	5	73	18.60						
	6	73	18.20						
	7	73	12.60						
	8	73	11.70						
	9	73	8.90						

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APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/02/04

260301
42 32 00.0 085 52 00.0
ALLEGAN LAKE
26 MICHIGAN

11EPALES 2111202
5 0008 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/14	13 50	0000	24.1	7.4	16	675	7.90	220	0.690	0.240	0.133	0.094
	13 50	0008	23.9	6.8		550	7.90	224	0.680	0.230	0.147	0.085
72/09/18	12 25	0000			24	556	8.06	203	0.850	0.180	0.206	0.076
	12 25	0004	20.9	6.4		550	8.08	203	0.860	0.150	0.224	0.067
72/11/14	15 35	0000	4.2		32	600	7.90	224	0.780	0.280	0.146	0.056
	15 35	0004	4.3	11.9		600	7.80	230	0.790	0.280	0.180	0.055

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/14	13 50	0000	66.6J
72/09/18	12 25	0000	28.5J
72/11/14	15 35	0000	1.6J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

260302
42 33 00.0 085 54 00.0
LAKE ALLEGAN
26 MICHIGAN

11EPALES
5

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P	
72/06/14	13 21	0000	23.8	11.3	18	600	8.10	228	0.460	0.140	0.108	0.072	
	13 21	0006	23.8	10.3		650	8.07	226	0.380	0.060	0.135	0.068	
72/09/18	12 05	0000			32	560	8.20	203	0.810	0.160	0.140	0.061	
	12 05	0004	20.8	7.7		580	8.20	203	0.800	0.150	0.150	0.062	V
72/11/14	15 25	0000	6.3	10.8	36	600	7.90	218	0.820	0.330	0.092	0.056	V

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L	
72/06/14	13 21	0000	17.7J	
72/09/18	12 05	0000	35.6J	
72/11/14	15 25	0000	0.3J	

J VALUE KNOWN TO BE [illegible] ERROR

STORET RETRIEVAL DATE 75/02/04

260303
42 34 00.0 085 57 00.0
ALLEGAN LAKE
26 MICHIGAN

11EPALES
5

2111202
0021 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/14	14 15	0000	24.1	5.2	36	675	7.80	226	0.520	0.540	0.136	0.100
	14 15	0010	23.7	5.2		660	7.80	232	0.510	0.550	0.136	0.104
	14 15	0020	21.3	2.4		675	7.68	226	0.500	0.560	0.303	0.095
72/09/18	11 45	0000			38	580	8.21	203	0.700	0.230	0.093	0.048
	11 45	0004	20.4	7.1		590	8.15	203	0.700	0.240	0.115	0.045
	11 45	0011	20.2	6.4		580	8.10	203	0.680	0.240	0.129	0.044
72/11/14	15 15	0000			36	600	7.90	232	0.840	0.400	0.122	0.058
	15 15	0004	6.3	10.0		600	7.80	236	0.850	0.390	0.098	0.060
	15 15	0010	6.3	9.9		600	7.80	222	0.870	0.380	0.101	0.059

26

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/14	14 15	0000	5.3J
72/09/18	11 45	0000	24.9J
72/11/14	15 15	0000	1.7J

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/04

2603A1 LS2603A1
42 34 00.0 085 51 00.0
KALAMAZOO RIVER
26055 15 ALLEGAN
O/LAKE ALLEGAN
MI 4.5 MI WNW ALLEGAN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	10	10	0.972	3.550	0.250	0.041	0.130
72/11/20	19	45	0.920	5.300	1.230	0.050	0.110
72/12/22	10	00	0.915	3.200	0.390	0.035	0.095
73/02/05			0.830	1.890	0.280	0.031	0.100
73/03/05	20	25	0.480	1.340	0.310	0.040	0.125
73/04/12	13	15	0.670	1.650	0.150	0.035	0.090
73/04/21	20	10	0.540	1.340	0.200	0.040	0.135
73/05/16	15	30	0.450	1.690	0.052	0.019	0.145
73/05/31			0.540	1.200	0.176	0.042	0.120
73/06/24			0.440	1.730	0.294	0.065	0.170
73/07/24			0.320	2.490	0.290	0.054	0.145
73/08/23			0.349	1.740	0.210	0.066	0.200
73/09/24			0.580	1.330	0.231	0.040	0.145

STORET RETRIEVAL DATE 75/02/04

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                                                                  270382          L2280382
                                                                  42 33 00.0 085 53 00.0
                                                                  KALAMAZOO RIVER
                                                                  26       15 ALLEGAN
                                                                  1/LAKE ALLEGAN
                                                                  ST HWY 40 & 89 BRDG NR ALLEGAN BELO STP
                                                                  11EPALES                    2111204
                                                                  4                           0000 FEET  DEPTH
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DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO3+NO2 -TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	70507 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/24	10	65	6.400	1.900	0.210	0.038	0.180
72/11/20	20	10	2.420	1.300	0.180	0.056	0.120
72/12/22	10	30	1.140	3.400	0.280	0.048	0.132
73/02/05			0.830	1.470	0.120	0.042	0.120
73/03/05	20	45	0.740	0.990	0.154	0.048	0.120
73/04/12	14	00	0.630	1.090	0.091	0.032	0.103
73/04/23	20	30	0.620	1.400	0.180	0.065	0.240
73/05/10	14	45	0.670	1.700	0.320	0.038	0.145
73/05/31			0.540	1.000	0.140	0.034	0.140
73/06/14			0.530	1.700	0.136	0.032	0.210
73/06/27			0.470	1.900	0.038	0.034	0.180
73/07/24			0.450	2.500	0.120	0.086	0.230
73/08/23			1.060	1.900	0.220	0.090	0.230
73/09/24			0.940	1.200	0.209	0.060	0.220

STORET RETRIEVAL DATE 75/02/04

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 26003A3          LS26003A3
42 31 00.0 085 51 00.0
KALAMAZOO RIVER
26      15 ALLEGAN
T/LAKE ALLEGAN
ST HWY 118 BRUG ALLEGAN ABOVE STP
11EPALES              2111204
4                     0000 FEET  DEPTH
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DATE FROM TO	TIME OF DAY	DEPTH FEET	00633 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/26	10 55		0.740	1.400	0.190	0.038	0.180
72/11/20	20 30		0.440	3.400	0.315	0.055	0.135
72/12/22	11 00		1.140	2.920	0.210	0.039	0.120
73/02/05	20 35		0.820	1.290	0.093	0.038	0.125
73/03/05	21 00		0.780	1.190	0.123	0.037	0.130
73/04/12	15 30		0.620	1.050	0.072	0.030	0.120
73/04/23	20 45		0.610	1.470	0.240	0.060	0.200
73/05/15	14 30		0.620	1.790	0.189	0.037	0.220
73/05/31			0.530	1.900	0.140	0.056	0.240
73/06/14			0.540	2.200	0.065	0.063	0.340
73/06/24			0.470	1.500	0.042	0.046	0.230
73/07/24			0.730	2.940	0.357	0.071	0.260
73/08/23			0.550	1.540	0.140	0.070	0.220
73/09/24			0.950	1.470	0.100	0.069	0.220

STORET RETRIEVAL DATE 75/02/04

2603A4 L52603A4
42 29 00.0 085 47 00.0
KALAMAZOO RIVER
26 15 GUBLES
1/LAKE ALLEGAN
TROWBRUG DAM 3 MI SE OF ALLEGAN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/25	11 00		0.730	2.100	0.210	0.035	0.200
72/11/20	20 50		0.950	2.100	0.348	0.060	0.154
72/12/22	11 30		1.140	3.440	0.305	0.040	0.140
73/02/05			0.870	1.150	0.084	0.044	0.140
73/03/05	21 20		0.780	1.050	0.095	0.040	0.140
73/04/12	14 30		0.640	1.100	0.108	0.036	0.120
73/04/23	21 00		0.610	1.320	0.169	0.058	0.175
73/05/16	14 15		0.610	1.295	0.176	0.046	0.240
73/05/31			0.510	1.400	0.110	0.056	0.210
73/06/24			0.540	2.300	0.240	0.058	0.280
73/07/24			0.680	3.300	0.200	0.080	0.280
73/08/23			0.430	1.700	0.132	0.072	0.296
73/09/28			0.980	1.320	0.105	0.069	0.230

STORET RETRIEVAL DATE 75/02/04

260381 LS260381
42 33 30.0 085 54 00.0
DOWNT CREEK
26 15 ALLEGAN
T/LAKE ALLEGAN
ST HWY 40 & 89 BRDG 2 MI NwALLEGAN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/28	10 40		0.234	2.050	0.150	0.007	0.029
72/11/20	20 00		0.330	2.600	0.290	0.014	0.050
72/12/22	10 15		0.490		0.100	0.019	0.048
73/01/12			0.315	0.440	0.048	0.019	0.020
73/03/05	20 45		0.420	0.500	0.035	0.010	0.030
73/04/12	13 30		0.200	0.480	0.006	0.006	0.020
73/04/23	20 20		0.138	0.660	0.018	0.009	0.040
73/05/16	14 00		0.138	1.050	0.027	0.005K	0.025
73/05/31			0.074	0.690	0.023	0.005K	0.030
73/06/14			0.100	1.050	0.031	0.005K	0.042
73/06/29			0.210	1.200	0.044	0.011	0.035
73/07/24			0.176	2.600	0.176	0.017	
73/08/23			0.095	0.640	0.026	0.013	0.045
73/09/28			0.115	0.400	0.027	0.010	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

260350 PR260350 P004000
42 32 00.0 085 51 30.0
ALLEGAN
26 15 ALLEGAN
U/LAKE ALLEGAN
LAKE ALLEGAN
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY	
73/01/30	08 00									
CP(T)- 73/01/30	17 00		0.420	31.500	5.900	3.645	11.750	0.475	0.542	
73/02/28	08 00									
CP(T)- 73/02/28	16 00		0.250	29.400	8.100	3.300	6.600	0.448	0.409	
73/03/29	00 00									
CP(T)- 73/03/29	08 00		0.180	24.000	6.000	3.700	6.400	0.741	0.536	
73/07/05	00 00									
CP(T)- 73/07/05	08 00		0.250	25.500	8.700	3.210	7.500	0.458	0.449	
63/08/01	00 00									
CP(T)- 73/07/31	07 00		0.170	21.000	5.700	1.300	7.230	0.424	0.525	(A) (B)
73/09/06	07 00									
CP(T)- 73/09/06	15 00			29.400				0.457	0.448	
73/10/04	07 00									
CP(T)- 73/10/04	16 00		0.090	44.000	17.000	4.100	8.300	0.800	0.500	
73/10/31	08 00									
CP(T)- 73/10/31	16 00		0.260	35.300	7.300	3.300	6.450	0.650	0.580	
73/12/04	07 00									
CP(T)- 73/12/04	16 00		0.390	19.000	0.490	1.800	4.400	0.616	0.560	
74/01/23	08 00									
CP(T)- 74/01/23	16 00		1.320	30.000	0.580	2.160	3.750	0.983	0.650	
74/02/03	07 00									
CP(T)- 74/02/03	16 00		0.640	17.000	1.680	3.840	6.500	0.775	0.748	
74/03/11	07 00									
CP(T)- 74/03/11	14 00		0.040		0.050K	0.050K		0.926	0.890	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

260351 AS260351 P083800
42 16 30.0 085 34 30.0
KALAMAZOO
26 7.5 KALAMAZOO
T/LAKE ALLEGAN
KALAMAZOO RIVER
11EMALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/15	00 00								
CP(T)-									
73/01/15	24 00		0.055	16.000	1.790	0.550	1.900	31.700	32.400
73/02/20	07 00								
CP(T)-									
73/02/21	07 00		0.035	32.000	1.680	0.340	3.500	31.800	30.200
73/03/14	00 00								
CP(T)-									
73/03/14	24 00		0.040	22.000	1.260	0.340	1.930	34.300	31.800
73/04/12	00 00								
CP(T)-									
73/04/12	24 00		0.045	14.000	1.300	0.490	1.730	32.300	31.900
73/05/30	00 00								
CP(T)-									
73/05/30	24 00		0.040	13.000	0.380	0.195	1.000	32.900	33.100
73/07/15	00 00								
CP(T)-									
73/07/15	24 00		0.110	22.000	1.400	0.440	1.200	33.200	32.100
73/09/12	00 00								
CP(T)-									
73/09/12	24 00		0.035	18.000	0.810	0.550	1.365	33.200	30.100
73/12/15	00 00								
CP(T)-									
73/12/15	24 00		0.320	19.500	2.000	0.350	0.880	28.700	30.600

STORET RETRIEVAL DATE 75/02/04

260352 TF260352 P003915
+42 27 30.0 085 42 30.0
OTSEGO
26 7.5 OTSEGO
T/LAKE ALLEGAN
KALAMAZOO RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/25	08 00								
CP(T)-			38.000	25.000	9.350	8.550	13.100	0.710	0.700
73/01/25	16 00								
73/02/20	08 00								
CP(T)-			0.300	25.000	4.000	7.000	10.500	0.691	0.710
73/02/20	16 00								
73/03/30	08 00								
CP(T)-			0.750	21.000	0.100	0.500	0.800	0.800	0.710
73/03/30	16 00								
73/04/17	08 00								
CP(T)-			0.420	24.000	4.850	5.000	10.300	0.743	0.680
73/04/17	16 00								
73/05/16	08 00								
CP(T)-			0.100	21.000	4.000	0.500	0.700	0.743	0.710
73/05/16	16 00								
73/07/12	08 00								
CP(T)-			0.300	17.200	1.080	0.300	0.300	0.780	0.750
73/07/12	16 00								
73/08/17	08 00								
CP(T)-			0.020	12.000	0.410	4.735	0.600	0.329	0.830
73/08/17	16 00								
73/09/13	08 00								
CP(T)-			0.280	15.400	0.450	7.240	0.650	0.721	0.800
73/09/13	16 00								
73/10/12	08 00								
CP(T)-			0.320	14.500	3.200	4.700	0.100	0.305	0.800
73/10/12	16 00								
73/11/20	08 00								
CP(T)-			0.600	21.000	4.500	6.300	7.500	0.726	0.720
73/11/20	16 00								
73/12/06	08 00								
CP(T)-			0.310	14.000	2.940	4.500	0.000	0.740	0.700
73/12/06	16 00								
74/01/23	08 00								
CP(T)-			0.450	15.500	2.300	4.130	0.200	0.760	0.770
74/01/23	16 00								

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STORET RETRIEVAL DATE 75/02/04

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260352 TP260352 P003915
42 27 30.0 085 42 30.0
OTSEGO
26 7.5 OTSEGO
T/LAKE ALLEGAN
KALAMAZOO RIVER
FEMALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50050 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/02/07 08 00 CP(T)- 74/02/07 16 00			0.250	20.000	3.300	5.000	7.900	0.800	0.740

36

STORET RETRIEVAL DATE 74/02/04

260353 TF260353 P002000
42 19 30.0 085 34 30.0
PARCHMENT
26 7.5 KALAMAZOO
T/LAKE ALLEGAN
KALAMAZOO RIVER
11EPALES
4 2141204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/31 00 00									
CP(T)-									
73/01/31 24 00			0.400	17.000	17.000	4.900	7.400	0.353	0.341
73/02/21 00 00									
CP(T)-									
73/02/21 24 00			0.300	23.000	1.700	5.000	7.300	0.355	0.344
73/03/29 00 00									
CP(T)-									
73/03/30 24 00			0.390	19.000	0.300	4.700	6.000	0.365	0.349
73/05/02 00 00									
CP(T)-									
73/05/02 24 00			1.100	15.000	0.450	1.100	2.200	0.371	0.355
73/06/05 00 00									
CP(T)-									
73/06/06 24 00			0.730	21.000	1.100	1.730	3.300	0.395	0.366
73/07/12 00 00									
CP(T)-									
73/07/12 24 00			0.310	14.000	0.500	1.320	2.100	0.364	0.359
73/08/28 00 00									
CP(T)-									
73/08/28 24 00				13.000	2.200	1.940	2.900	0.394	0.354
73/12/28 00 00									
CP(T)-									
73/12/28 24 00			0.940	31.000	0.400	0.830	1.850	0.317	0.320
74/01/30 00 00									
CP(T)-									
74/01/30 24 00			0.840	14.000	0.170	0.720	2.150	0.327	0.330

STORET RETRIEVAL DATE 73/02/04

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25?354 Tr260354 P003020
42 27 00.0 085 39 00.0
PLAINWELL
23 T.5 OSTEGO
T/LAKE ALLEGAN
KALAMAZOO RIVER
ILEPALES 2141204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/23 08 00									
CP(T)-			0.700	17.000	5.040	3.100	5.200	0.528	0.649
73/01/23 16 00									
73/02/22 08 00									
CP(T)-			0.250	25.000	11.000	4.100	7.000	0.358	0.395
73/02/22 16 00									
73/04/05 00 00									
CP(T)-			4.100	4.000	0.930	1.500	2.150	0.792	0.620
73/04/05 08 00									
73/05/02 00 00									
CP(T)-			0.510	1?.000	5.000	3.125	4.000	0.560	0.631
73/05/02 08 00									
73/06/04 04 00									
CP(T)-			0.510	1?.000	1.100	2.720	4.000	0.612	0.608
73/06/04 16 00									
73/07/05 08 00									
CP(T)-			0.310	23.200	5.000	4.370	6.500	0.485	0.795
73/07/05 16 00									
73/08/03 08 00									
CP(T)-			0.250	24.000	9.140	5.750	7.500	0.397	0.365
73/08/03 16 00									
73/09/04 08 00									
CP(T)-			0.037	25.000		3.400	7.700	0.440	0.372
73/09/04 16 00									
73/10/01 08 00									
CP(T)-			0.250	14.000	2.750	2.100	5.100	0.707	0.407
73/10/01 16 00									
73/11/01 08 00									
CP(T)-			0.250	30.000	11.200	4.200	7.100	0.350	0.382
73/11/01 16 00									
73/12/05 08 00									
CP(T)-			0.450	2?.000	4.300	2.420	5.100	0.540	0.411
73/12/05 16 00									
74/01/04 04 00									
CP(T)-			0.320	13.000	5.100	3.230	4.400	0.508	0.411
74/01/04 16 00									

STORET RETRIEVAL DATE 75/02/04

250354 TF260354 P003020
42 27 00.0 085 39 00.0
PLAINWELL
26 7.5 OSTEGO
T/LAKE ALLEGAN
KALAMAZOO RIVER
TIEPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/02/05	08 00								
CP(T)-									
74/02/05	16 00							0.694	0.582

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